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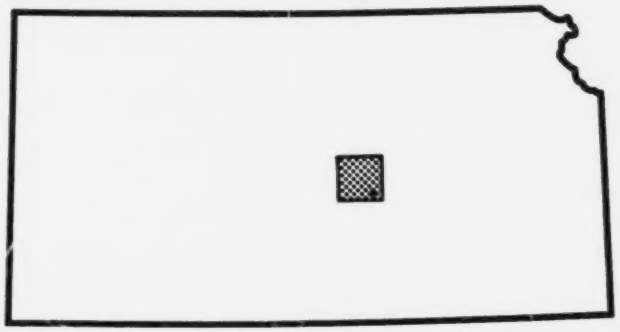
ORIGINAL

FLOOD INSURANCE STUDY

26

CITY OF MOUNDRIDGE, KANSAS

McPHERSON COUNTY



JUNE 15, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 200218

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Flood Profiles

Black Kettle Creek	Panel	01P
Black Kettle Creek Tributary No. 1	Panel	02P

Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map

FLOOD INSURANCE STUDY

CITY OF MOUNDRIDGE,
MCPHERSON COUNTY, KANSAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Moundridge, McPherson County, Kansas, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Moundridge to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these Federally-supported studies are based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3 (d). In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Bucher and Willis for the Federal Emergency Management Agency, under Contract No. H-4645. This study was completed in January 1980.

1.3 Coordination

On March 13, 1978, the identification of streams requiring detailed study was accomplished in a meeting attended by personnel of FEMA; the City of Moundridge; the Study Contractor; and a representative of the Kansas Board of Agriculture, Division of Water Resources. Subsequent coordination for this study included contact with the U.S. Geological Survey (USGS); the Department of Agriculture, Soil Conservation Service (SCS); the U.S. Army Corps of Engineers (COE), Tulsa District; the Department of Interior, Water and Power Resources Service (WPRS); the Kansas Water Resources Board (KWRB); the Kansas Board of Agriculture, Division of Water Resources; the Kansas Department of Transportation (KDOT); and Wilson and Company Engineers and Architects.

On March 23, 1981, preliminary flood elevations, flood boundaries and floodway delineations were reviewed with representatives of the city, the Study Contractor and the Kansas Board of Agriculture, Division of Water Resources at a technical meeting, in place of the intermediate meeting.

On January 26, 1982, the results of the work by the Study Contractor were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Moundridge, McPherson County, Kansas. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, and areas of projected development or proposed construction through January 1985.

Approximate methods of analysis were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to and agreed upon by FEMA and the City of Moundridge.

Floods caused by overflow of Black Kettle Creek from just north of Hoch Street to about 1,500 feet north of Durst Street and an unnamed stream, north of Cole Street called in this study Black Kettle Creek Tributary No. 1 from its confluence with Black Kettle Creek to about 1,200 feet upstream, were studied in detail. Flooding on another unnamed stream, north of the Missouri Pacific tracks in the eastern part of Moundridge called in this study Black Kettle Creek Tributary No. 2, and an unnamed stream north of old U.S. Highway 81 called in this study Black Kettle Creek Tributary No. 3 were studied by approximate methods.

2.2 Community Description

The City of Moundridge is located in southern McPherson County in central Kansas. It is approximately 138 miles southwest of Topeka, 41 miles north of Wichita, and 15 miles southeast of McPherson. Moundridge is completely surrounded by unincorporated McPherson County. The community had a population of 1,425 according to the 1980 Census (preliminary), which is an increase of 12.1 per cent from the 1970 Census figure of 1,271 (Reference 1).

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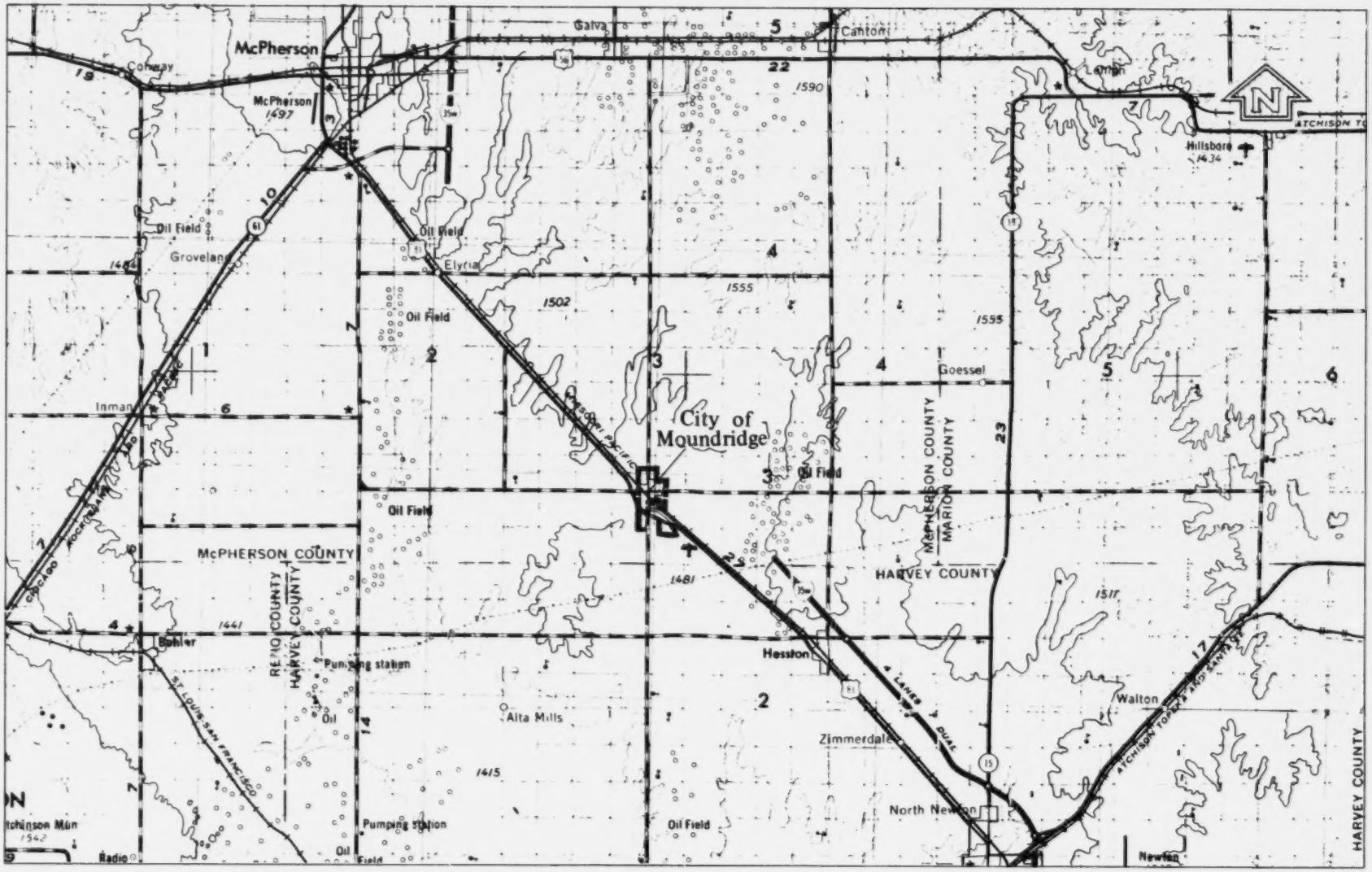

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT ASENCY

CITY OF MOUNDRIDGE, KS
(McPHERSON CO.)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

In 1874, Christian Krehbiel led 30 Mennonites from Summerfield, Illinois to Kansas and settled in the area around the Village of Christian. Later in that year, Mennonites from other parts of the United States, Russia, and Germany arrived at the settlement. The Atchison, Topeka and Santa Fe Railway selected their right-of-way about one mile north of the community of Christian and a gradual move north began. The new site was on a mound which had been used by the Indians as a lookout point. In 1886, a new town was laid out which included a post office, general stores, a bank, a mill, a hotel and a restaurant. The townsite was incorporated the next year, 1887, as the City of Moundridge with a population of 400. The main street of the community, Christian Avenue, was named after the original settlement.

Moundridge has remained a farming community and has a mayor-city council-city administrator form of government (Reference 2).

The Moundridge area has a continental climate with a yearly precipitation from 15.24 inches in 1956 to 49.12 inches in 1951, with a yearly average precipitation of approximately 29.25 inches. The major portion of the yearly precipitation occurs as rainfall from April through October, with the heaviest amounts usually occurring from high intensity thunderstorms. The temperatures in the Moundridge area range from a high of 117 degrees Fahrenheit (F.) on July 18, 1936; July 24, 1936; and August 12, 1936; to a low of -27 degrees F. on February 12, 1899 (Reference 3).

Moundridge is located on a slightly undulating area along Black Kettle Creek. The soils are typically deep, moderately deep, and shallow, dark grayish-brown and very dark grayish-brown silt loams, silty clay loams and silty clays, with depths of more than 36 inches to the secondary carbonate deposits (Reference 4).

Black Kettle Creek, which flows north to south through the eastern part of Moundridge, has its headwaters four to five miles north and east of Moundridge and has a drainage area of approximately 6.8 square miles at the Missouri Pacific structure. Black Kettle Creek Tributary No. 1, which joins Black Kettle Creek from the east just north of Cole Street, has its headwaters about two miles northeast of Moundridge and has a drainage area of approximately 1.1 square miles at its confluence with Black Kettle Creek.

The existing development within the flood plains is mainly residential. The developing areas of Moundridge, in general, surround the present community and are on higher ground.

2.3 Principal Flood Problems

The low-lying areas near the streams in Moundridge are subject to flooding caused by thunderstorms in the immediate vicinity and upper watershed. The community has indicated that very little structural flooding has occurred.

2.4 Flood Protection Measures

Presently, no flood protection structures are located within the City of Moundridge or in the immediate vicinity. However, nonstructural measures of flood protection are being utilized to aid in the prevention of future flood damages. These measures are in the form of land use regulations which use the best available information to control further building within areas that have a high risk of flooding (Reference 5).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 per cent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one per cent chance of annual occurrence) in any 50-year period is about 40 per cent (four in ten), and for any 90-year period, the risk increases to about 60 per cent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

The discharges for Black Kettle Creek were computed by several different methods to determine the procedure which best fits the stream and area. The regression equations in Technical Report No. 11, "Magnitude and Frequency of Floods in Kansas" (Reference 6) were deemed unsuitable because the drainage area of Black Kettle Creek at Moundridge is less than 10 square miles. Consequently, a regional gage analysis, using six USGS gages in the area and fitting the best curves through the 10-, 50-, 100- and

500-year discharges, was performed by the Study Contractor. This analysis was used to establish flows along Black Kettle Creek. The analysis was based on the following USGS gages:

Gage Number	Years of Record
07147200	19
07145300	19
07146700	19
06877200	19
07146570	14
06870300	21

The discharges for Black Kettle Creek Tributary No. 1 were also established from the regional gage analysis of the six USGS gages.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
BLACK KETTLE CREEK					
Just upstream of Hoch Street	7.01	1,780	3,175	3,810	5,300
At Durst Street	5.61	1,550	2,710	3,275	4,500
BLACK KETTLE CREEK TRIBUTARY NO. 1					
Just upstream of confluence with Black Kettle Creek	1.08	580	950	1,140	1,500

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Cross section data for Black Kettle Creek and Black Kettle Creek Tributary No. 1 were obtained by field survey methods with supplemental cross section data taken from USGS topographic maps at a scale of 1:24000 and contour interval of five feet (Reference 7). Bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles. For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map.

Roughness coefficients (Manning's "n"), for all streams, were estimated by field inspection and aerial photographs of the Moundridge area at a scale of 1:12000 (Reference 8). For Black Kettle Creek, roughness coefficients for the main channel ranged from 0.035 to 0.045 and for the remaining portion of the flood plain the "n" values ranged from 0.050 to 0.085. For Black Kettle Creek Tributary No. 1, the roughness coefficient for the main channel was 0.040 and for the remaining portion of the flood plain the "n" value was 0.040.

Water-surface profiles were developed using a HEC-2 computer step-backwater program (Reference 9). Profiles were determined for the 10-, 50-, 100- and 500-year floods. The starting water-surface elevations for Black Kettle Creek and Black Kettle Creek Tributary No. 1 were determined using the slope-area method.

Flooding on the approximate study streams, Black Kettle Creek Tributary No. 2 and Black Kettle Creek Tributary No. 3 occurs due to backwater effects from the parent stream behind the embankments for the Missouri Pacific Railroad and old U.S. Highway 81, respectively. Water-surface elevations for these areas were taken from the parent stream elevation just upstream of these embankments. These backwater elevations were determined to be higher than the free flow elevations.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles are, therefore, considered valid only if hydraulic structures, in general, remain unobstructed and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the elevations determined at each cross section; between cross sections the boundaries were interpolated using a USGS topographic map at a scale of 1:24000 with contour intervals of five feet (Reference 7). For each approximate study stream, the flood boundaries were delineated using the above referenced topographic map.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map. Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced.

The floodways for this study were normally computed on the basis of equal conveyance reduction from each side of the flood plain and engineering judgment to try to maintain a 1.0-foot increase in elevation over the 100-year water-surface elevation.

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The results of these computations were tabulated at selected cross sections for each stream segment for which a floodway was computed (Table 2). Portions of the Black Kettle Creek floodway lie outside of the corporate limits of the City of Moundridge. The floodway for Black Kettle Creek Tributary No. 1 is completely outside the corporate limits of the City of Moundridge.

As shown on the Flood Boundary and Floodway Map, the floodway boundaries were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

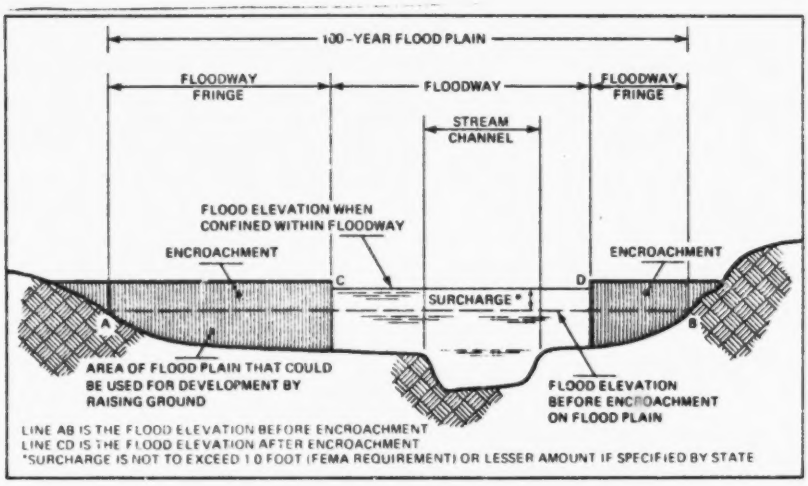
100-YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

The floodways in this report are recommended to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHF), and flood insurance zone designations for each flooding source affecting the City of Moundridge.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
BLACK KETTLE CREEK								
A	815	210/55[3]	1770	2.2	1472.7	1472.7	1473.2	0.5
B	895	210/80[3]	1741	2.2	1472.7	1472.7	1473.2	0.5
C	1275	211	1568	2.4	1472.8	1472.8	1473.4	0.6
D	2007	210	1460	2.6	1473.1	1473.1	1474.0	0.9
E	2427	210	1496	2.5	1473.2	1473.2	1474.1	0.9
F	2766	185	1311	2.9	1474.3	1474.3	1475.3	1.0
G	3992	292	2097	1.6	1474.9	1474.9	1475.9	1.0
H	4512	285/265[3]	2019	1.6	1475.0	1475.0	1476.0	1.0
BLACK KETTLE CREEK TRIBUTARY NO. 1								
A	790[2]	85[4]	208	5.5	1474.7	1473.1[5]	1474.1	1.0

[1]FEET ABOVE LIMIT OF FLOODING AFFECTING COMMUNITY 560 FEET DOWNSTREAM OF MISSOURI PACIFIC RAILROAD

[2]FEET ABOVE CONFLUENCE WITH BLACK KETTLE CREEK

[3]TOTAL WIDTH / WIDTH WITHIN CORPORATE LIMITS

[4]THIS WIDTH IS BEYOND CORPORATE LIMITS

[5]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM BLACK KETTLE CREEK

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOUNDRIDGE, KS

(McPHERSON CO.)

FLOODWAY DATA

BLACK KETTLE CREEK

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 per cent of the reach.

Average Difference Between 10- and 100-year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the City of Moundridge are shown on the Flood Profiles and are summarized in Table 3, "Flood Insurance Zone Data."

5.2 Flood Hazard Factors

The FHF is used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the City of Moundridge was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A: Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations are shown or FHFs determined.

Zones A4, A7:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations are shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Moundridge is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by FEMA.

6.0 OTHER STUDIES

A Flood Insurance Study for McPherson County, Unincorporated Areas, Kansas is currently in progress (Reference 10). The county study will match exactly the Flood Insurance Study for the City of Moundridge.

A Flood Hazard Boundary Map has been published for the community (Reference 11). The differences between the Flood Hazard Boundary Map and this study are justified due to the more detailed nature of this Flood Insurance Study.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
BLACK KETTLE CREEK							
REACH 1	0001	–3.6	–1.0	2.2	035	A7	VARIES–SEE MAP
REACH 2	0001	–2.0	–0.4	1.2	020	A4	VARIES–SEE MAP

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOUNDRIDGE, KS
(McPHERSON CO.)

FLOOD INSURANCE ZONE DATA

BLACK KETTLE CREEK

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, Federal Emergency Management Agency, 911 Walnut Street, Kansas City, Missouri 64106.

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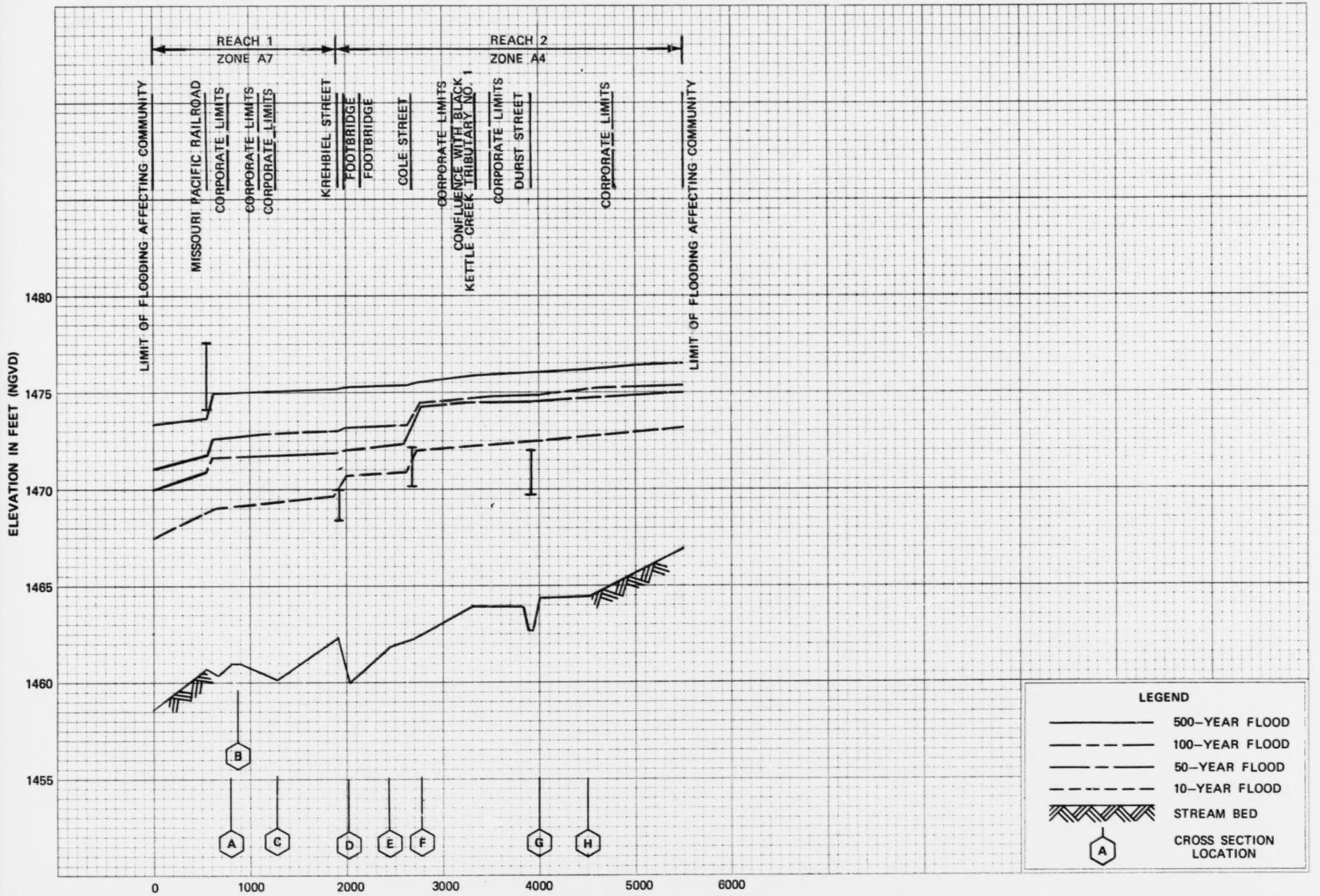

STREAM DISTANCE IN FEET ABOVE LIMIT OF FLOODING AFFECTING COMMUNITY
(LIMIT OF FLOODING AFFECTING COMMUNITY IS 560 FEET DOWNSTREAM OF THE MISSOURI PACIFIC RAILROAD)

FLOOD PROFILES

BLACK KETTLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOUNDRIDGE, KS
(McPHERSON CO.)

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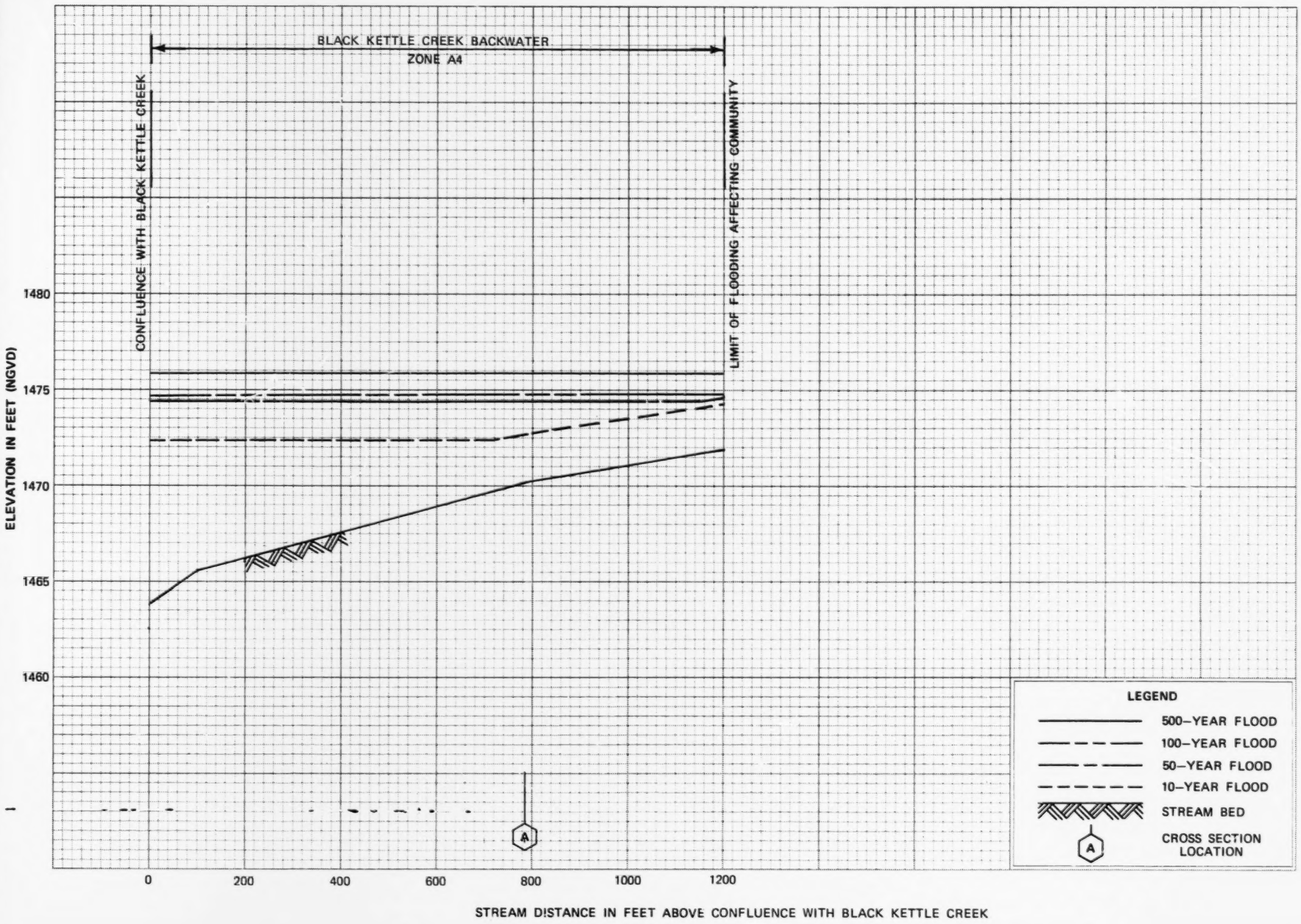
BEST DOCUMENT AVAILABLE



FLOOD PROFILES

BLACK KETTLE CREEK TRIBUTARY NO. 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF MOUNDRIDGE, KS
(McPHERSON CO.)

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